Remote Sensing Laser Survey and Imagery Technologies for Expediting Airport Mapping and Asset Management Applications

2014 FAA Worldwide Airport Technology Transfer Conf,

Galloway, New Jersey, August 5-7, 2014

Memphis International Airport

Largest air freight serving airport in the world

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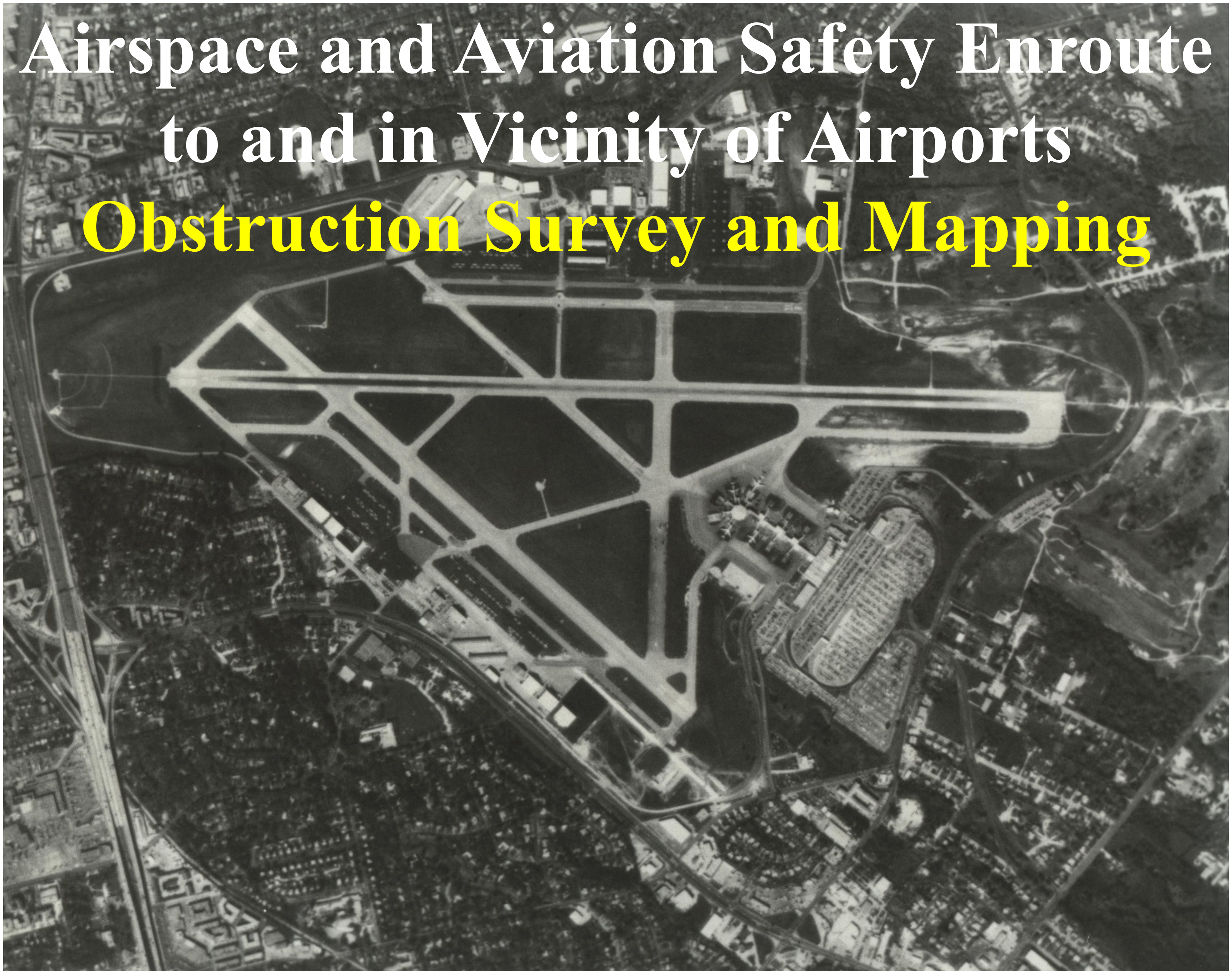
http://www.olemiss.edu/projects/cait/ncitec/


Airspace and Aviation Safety Enroute
to and in Vicinity of Airports
Obstruction Survey and Mapping

Background

- **An Obstacle/Obstruction Identification Surface (OIS) defines SAFE altitudes for approaches/landings and departures.**
- **The Next Generation Air Transportation System (NextGen)**
- **Satellite based airport flight procedures (>40% airports)**
- The FAA standards for identifying obstructions to navigable air space apply to:

  hilly terrain, natural-growth objects (**tall trees**), existing and planned manmade objects

  (**tall buildings, cell and TV towers, water towers, power transmission towers, tall electric light poles, windmills**), and temporary construction-related objects, **cranes**.

Objectives

- To present airport application of Airborne LIDAR based obstruction survey methods and their benefits
- To show 3D visualization of airport infrastructure using imagery data for asset management



ACRP 03-01 Project

http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=135

Light Detection and Ranging (LIDAR) Deployment for Airport Obstructions Surveys

Project Period: January 30, 2007 – December 31, 2009

TRB Project Manager: Dr. Andrew Lemer

TRB Oversight: ACRP03-01 Panel & FAA Reps

- **PI: Waheed Uddin** cvuddin@olemiss.edu
  - **Professor of Civil Engineering, University of Mississippi**
- **Co-PI: Christopher Parrish** Chris.Parrish@noaa.gov
  - **Research Scientist, NOAA** – **National Geodetic Survey (NGS)**
- **Other NGS Staff: Jason Woolard, Cartographer**
- **Consultants:** Frank Scarpace, Alan Vonderohe, Bill Gutelius, David Ward, Robert Hutchins

Subcontractors: IAVO Research and Scientific

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OIS Surveys

- **Applicable survey standard documents - FAA**

AC 150/5300-16 A "General Guidance and Specifications for Aeronautical Surveys: Establishment of **Geodetic Control** and Submission to the National Geodetic Survey" September 15, 2007

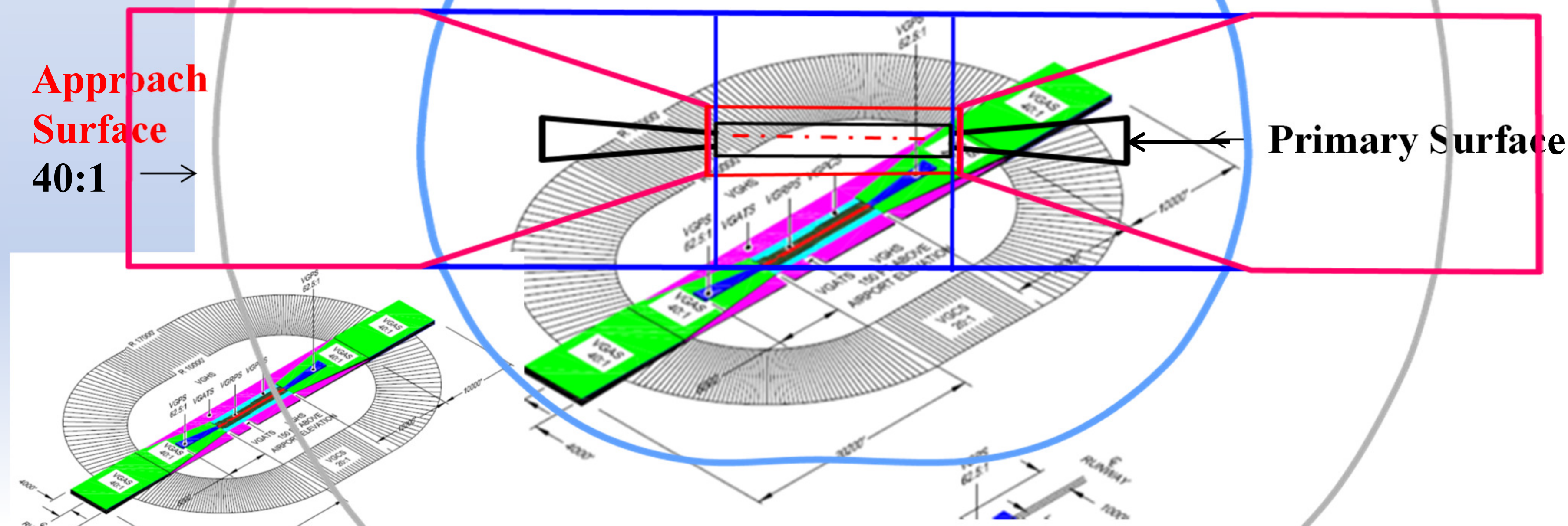
AC 150/5300-17 B ": Standards for Using Remote Sensing Technologies in Airport Surveys" September 30, 2011 Identifies the requirements for and how to collect the required imagery. **Allows LIDAR survey**

AC 150/5300-18 B "General Guidance And Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection And Geographic Information System (GIS) Standards" May 21, 2009

Replaces Part-77 surfaces.

OIS Surveys

- **AC 150/5300-18B, Table 2.1** provides information on:
  Two types of “obstruction surveys”
  1) Vertically Guided 2) Non-Vertically Guided



Vertically guided (VG) instrument approaches such as ILS, PAR, MLS, LPV, TLS, RNP and Baro/VNAV

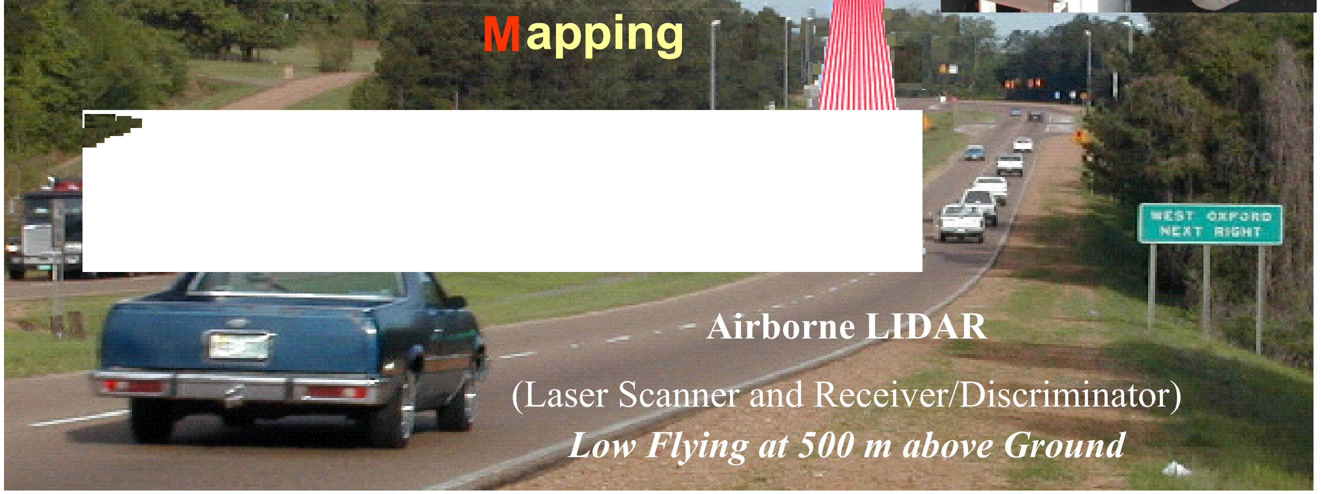
Visual or Non-Vertically guided (NVG) operations (Lateral Navigation (LNAV), Localizer Performance (LP), VOR, NDB, Localizer, Localizer Directional Aid (LDA), etc.)

Remote Sensing Survey Technologies

The term LASER is an acronym for:

L ight
A mplification by
S timulated
E mission of
R adiation

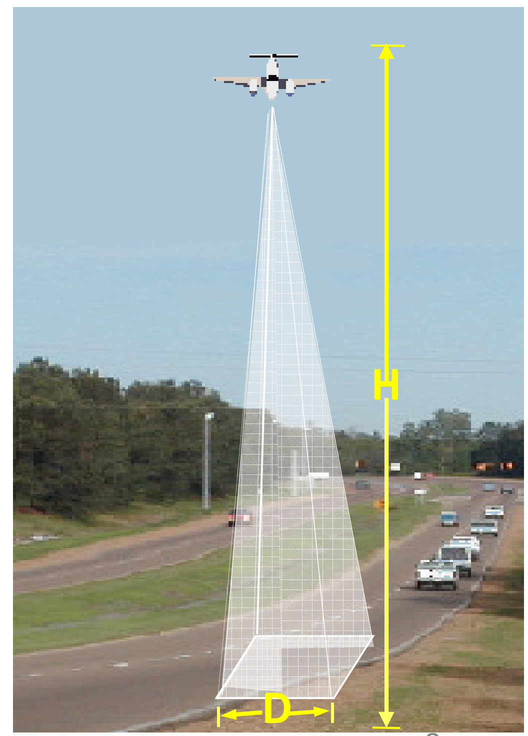
The term LIDAR is an acronym of
"LIght Detection And Ranging."



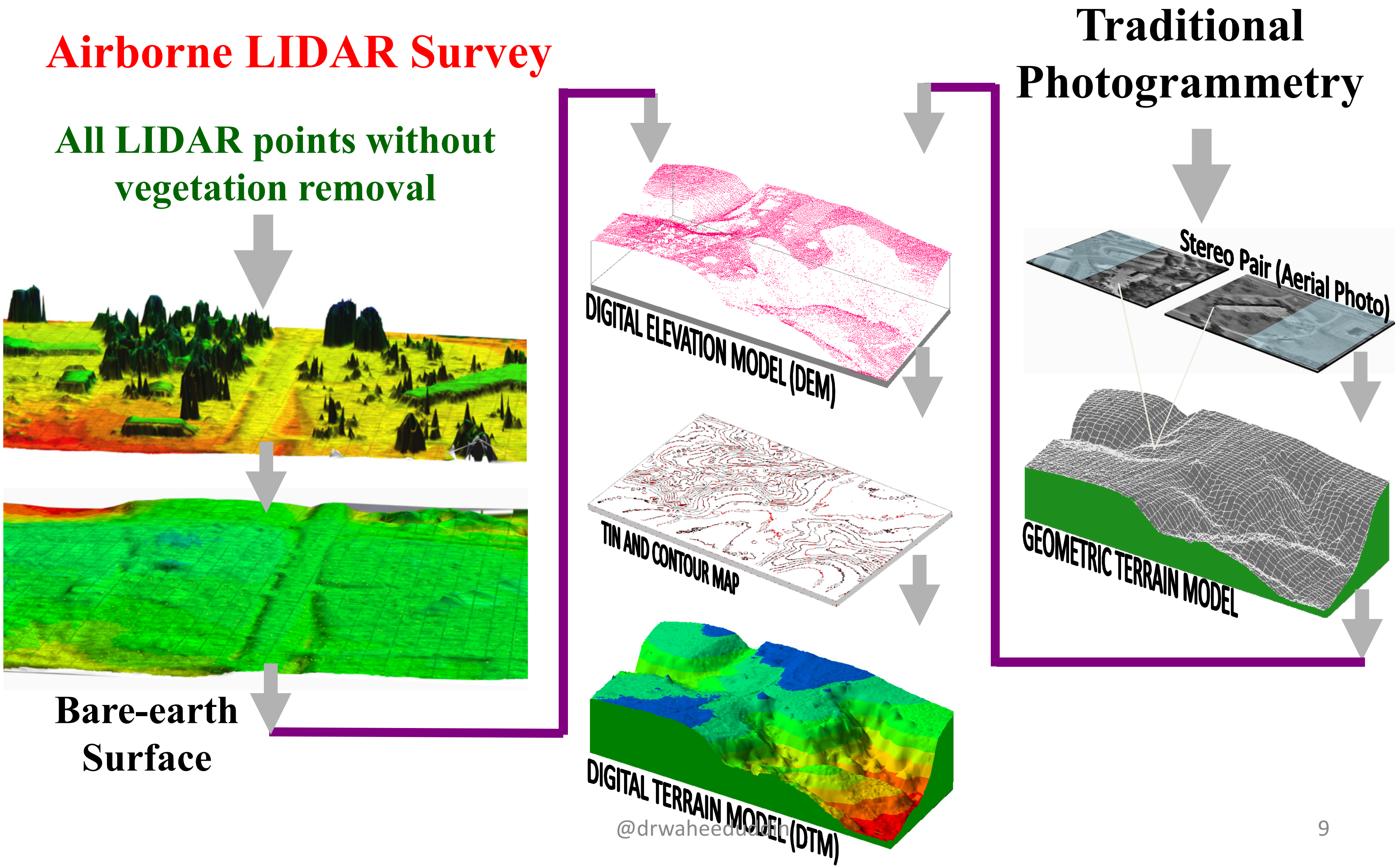
Traditional
Aerial Photography/ Photogrammetry

Flying at high to low height above Ground

Low Flying at 730 m above ground for high resolution



Workflow for Topographic Mapping & Terrain Modeling



Key Differences of LIDAR and Traditional Photogrammetry for Obstruction Surveys

Key Parameters	**Aerial Photography/ Photogrammetry**	**Airborne LIDAR**
Operating Constraints	**No operations** during **nighttime**, poor visibility	Operations **any time** during **day and night**
Seasonal Restrictions	Operational only during **leaf-on period** in wooded areas	Operational for more periods throughout year
Environmental Effects	Subject to flight rules of **visibility & ceiling**	Subject to flight rules of **visibility & ceiling**
Terrain & Built-up Area Constraints	Can be **inaccurate** in extremely wooded areas, problem with shadow areas and sun angle	**More reliable** data for canopy and ground areas, problem with shadow areas

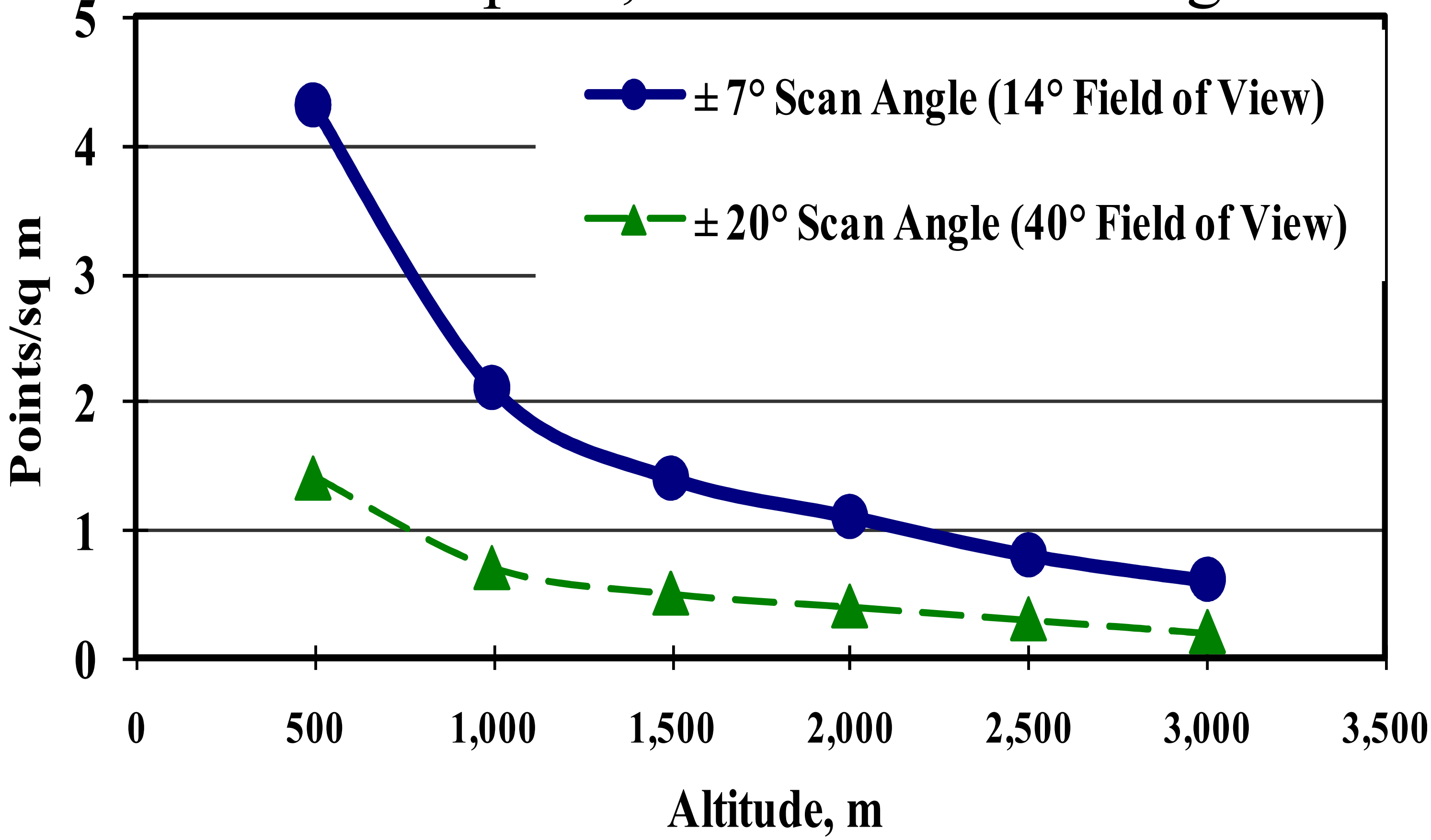
Reliable Hardware / Analysis Software: Available Commercially

Key Differences Between LIDAR and Photogrammetry

- Traditional photography provides a **permanent photo** record of the terrain, which is a clear advantage.
- LIDAR **needs a recent georeferenced imagery** of the study area to identify the types of features and potential obstacles and verify the objects automatically extracted from computational analysis.
- LIDAR is **not constrained by operating limitations** of traditional photography method relative to nighttime and seasonal operating constraints.
- Photogrammetry is **more time consumin**g; manual effort for stereoscopic post-processing; requires **seed** elevation.
- LIDAR is **computationally efficient**; less time consuming; and **easy to reanalyze** for different obstacle free imaginary surfaces.

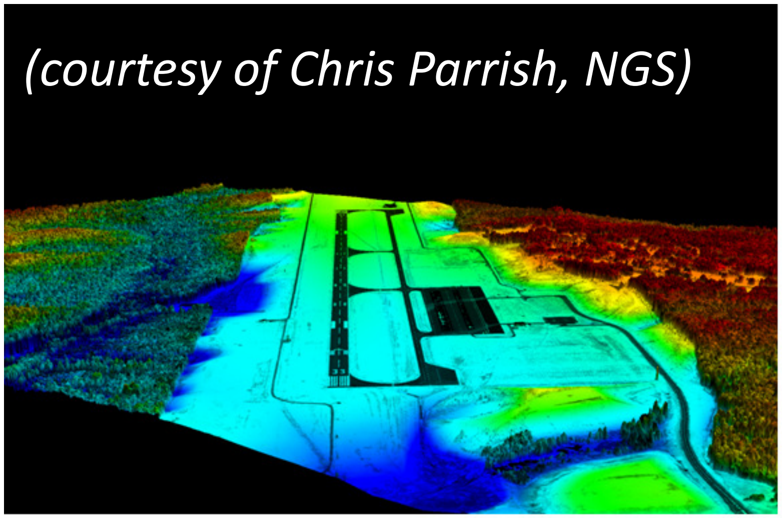
LIDAR Points Density vs. Flying Altitude for the Assumed Sensor Data

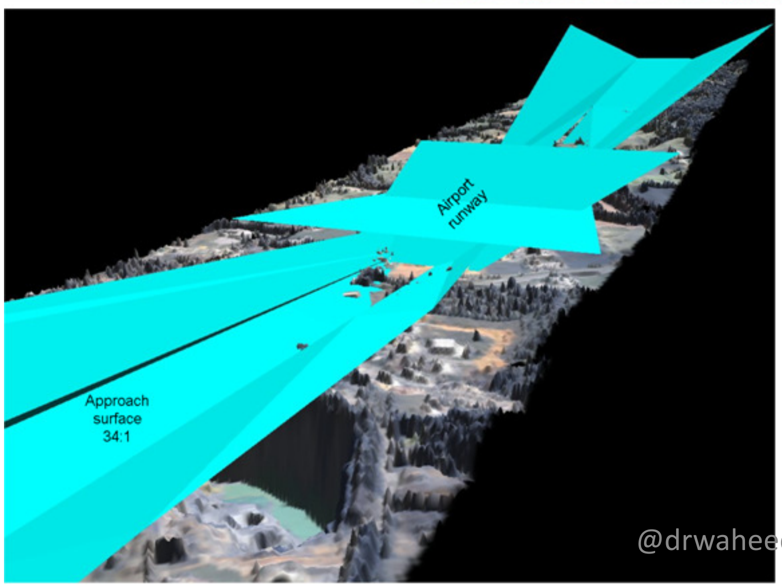
A nadir-looking LIDAR setting of 33 kHz PRF; 125 knots aircraft speed; a 7^o or 20^o scan angle

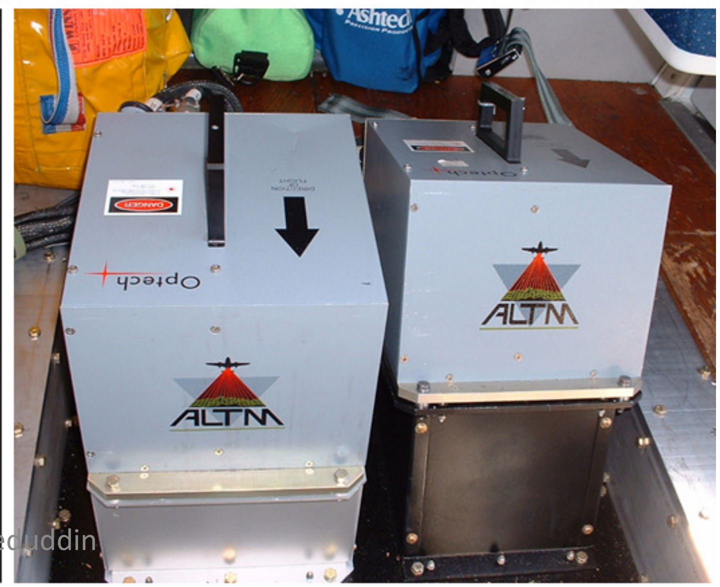


LIDAR-derived digital surface model

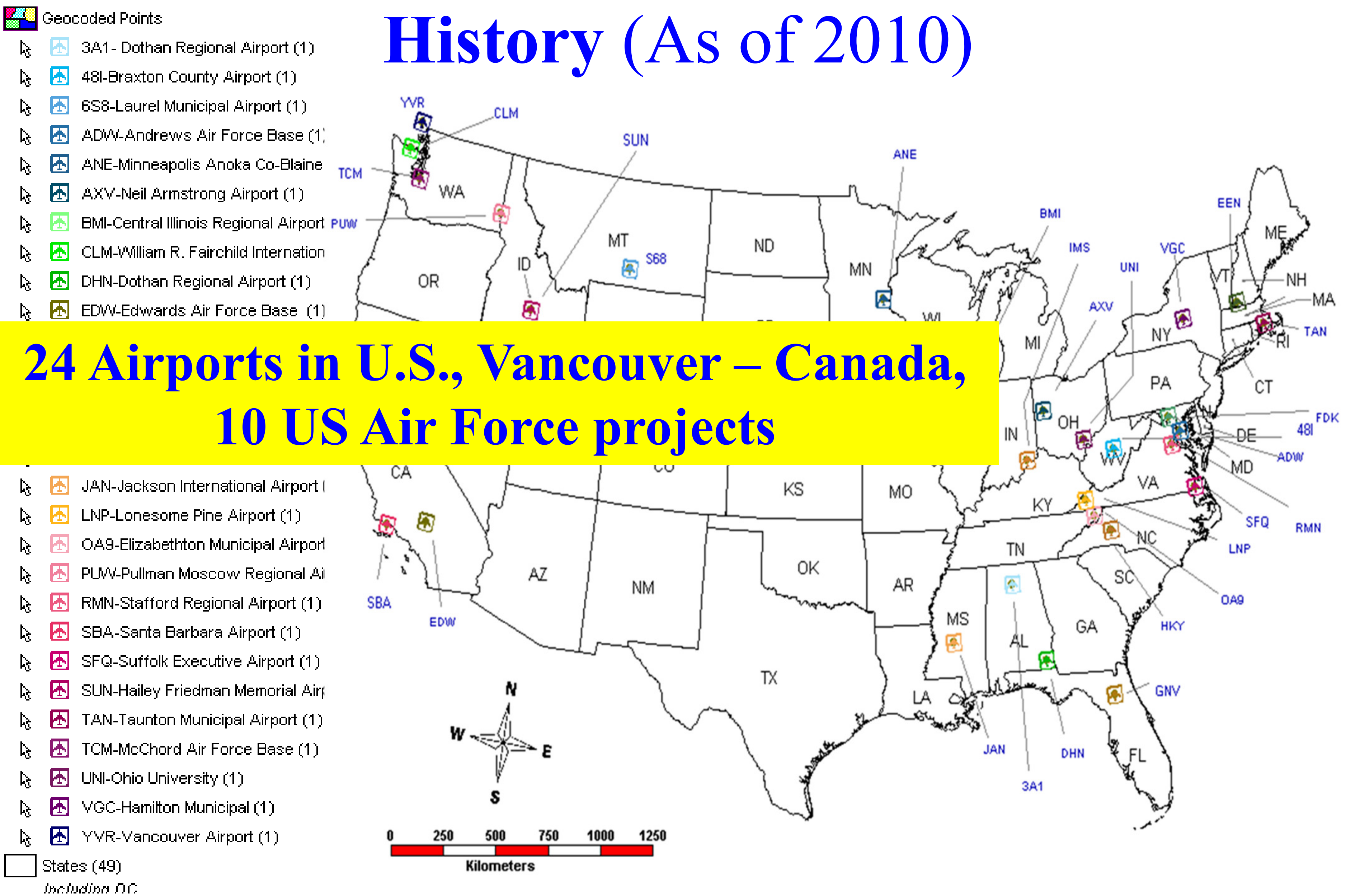
Stafford Regional Airport (NGS Project)





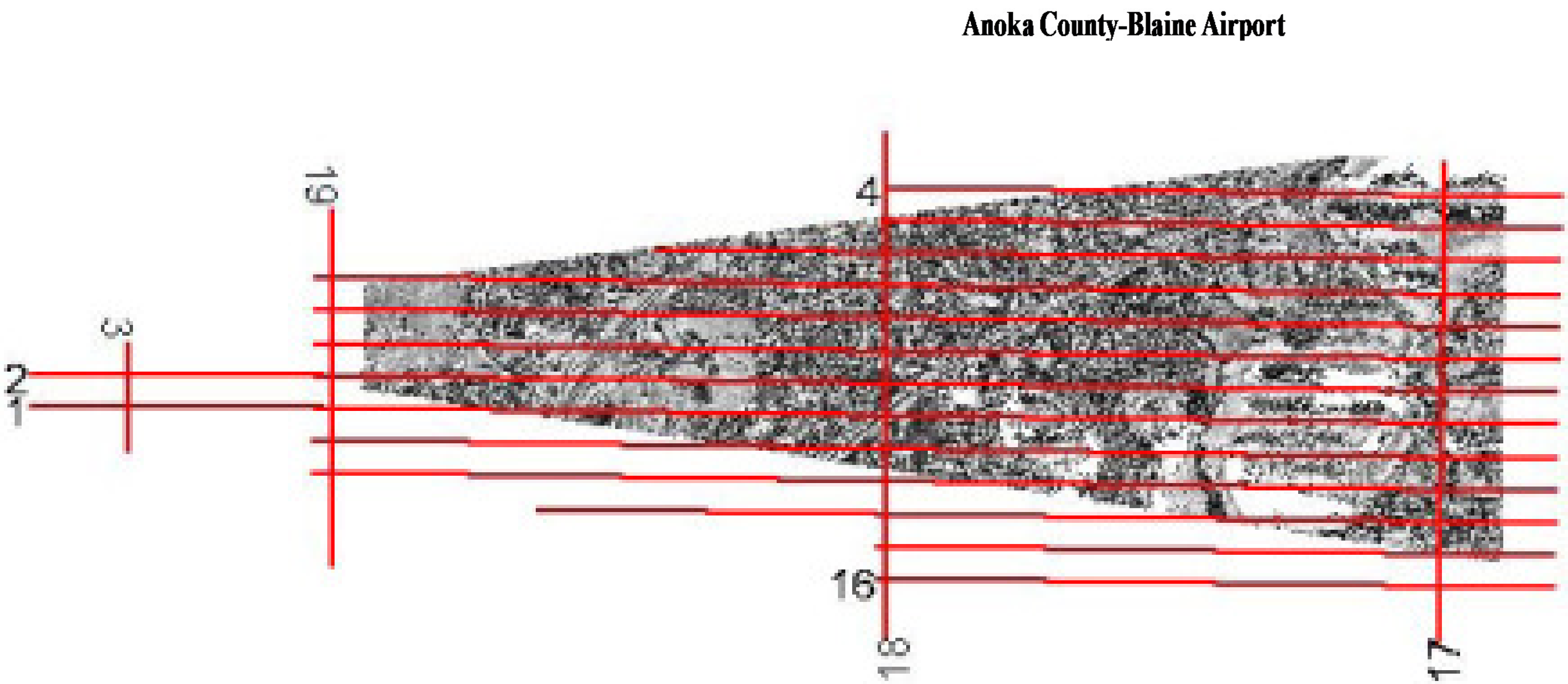


Airports with LIDAR Obstruction Survey History (As of 2010)



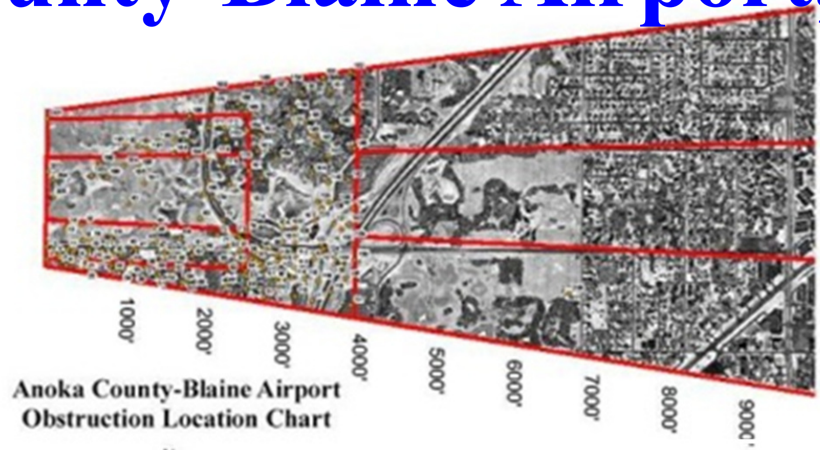
24 Airports in U.S., Vancouver – Canada, 10 US Air Force projects

Airborne LIDAR for Obstruction Survey, Anoka County-Blaine Airport, Minnesota

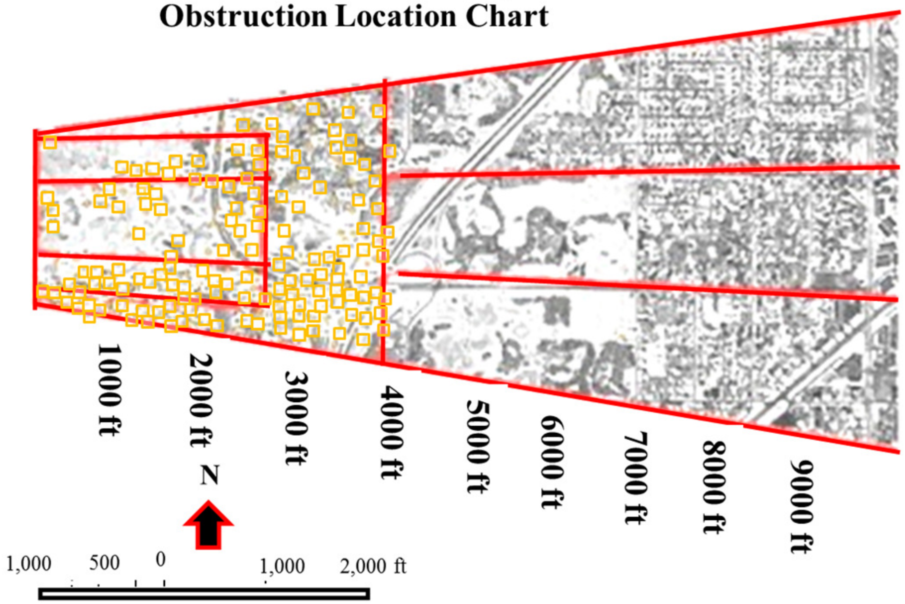


LIDAR Mission Planning and Flightlines

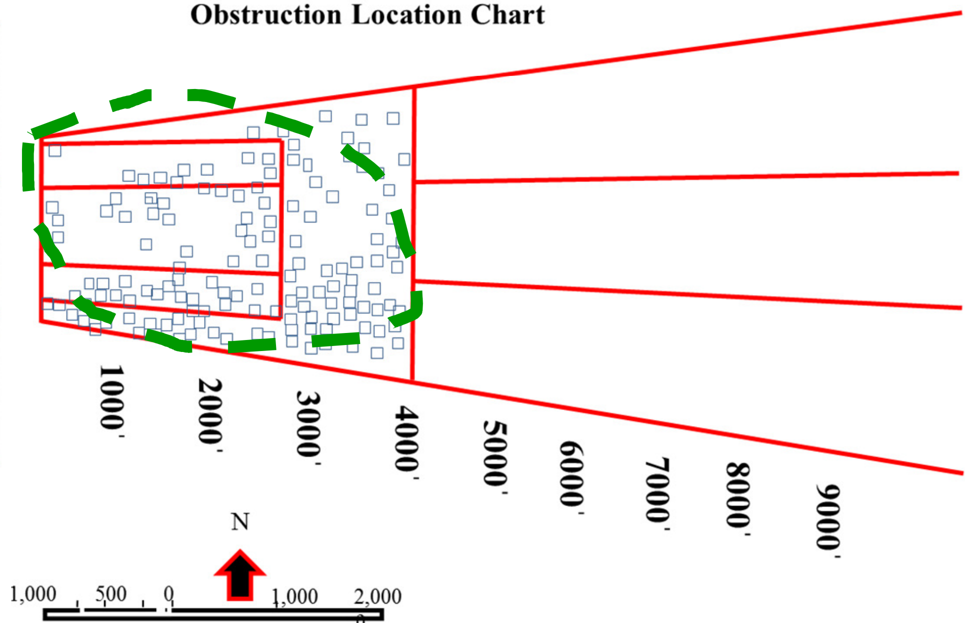
LIDAR Survey-based Obstruction Mapping, Anoka County-Blaine Airport, Minnesota



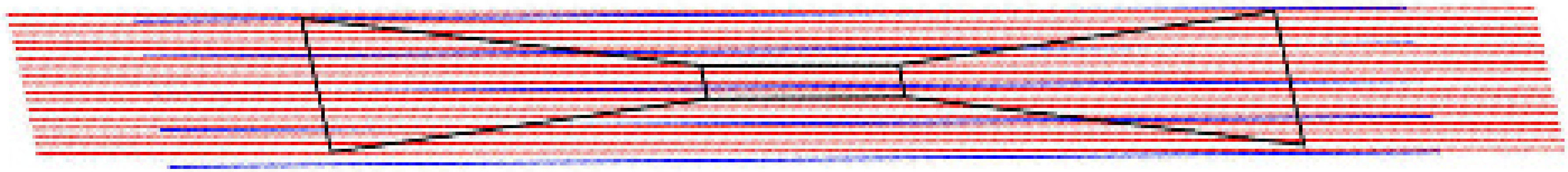
Anoka County-Blaine Airport
Obstruction Location Chart

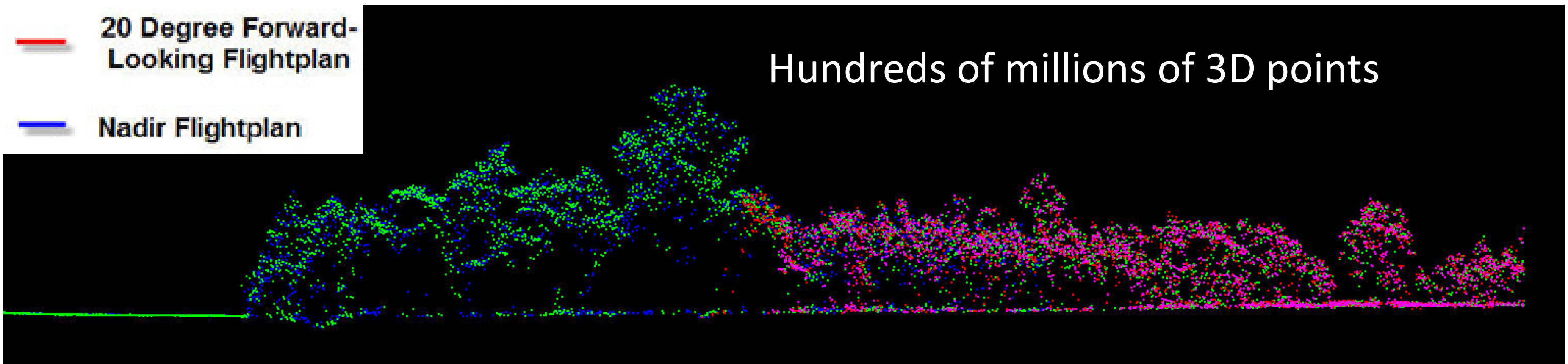


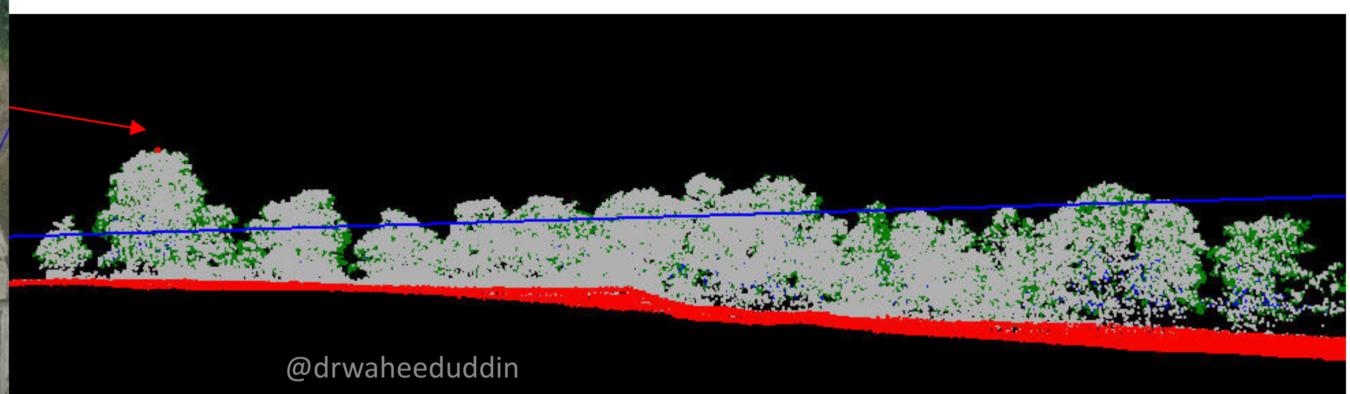
Anoka County-Blaine Airport
Obstruction Location Chart



OPTIMAL GEOMATICS, Inc.
LIDAR Methodology



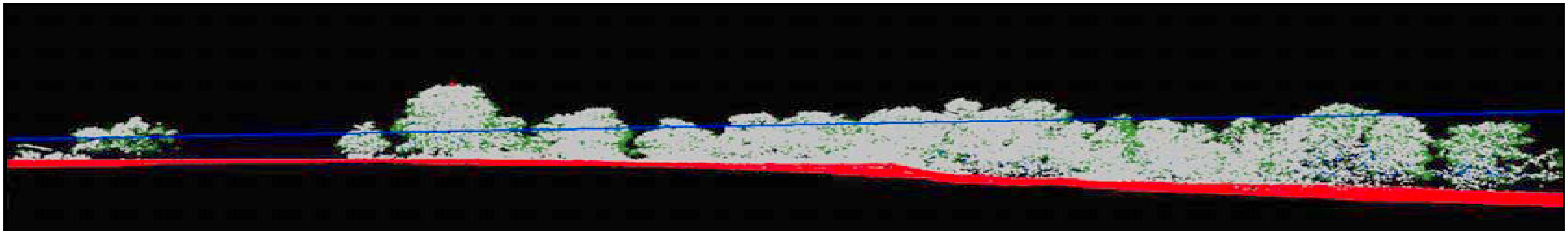


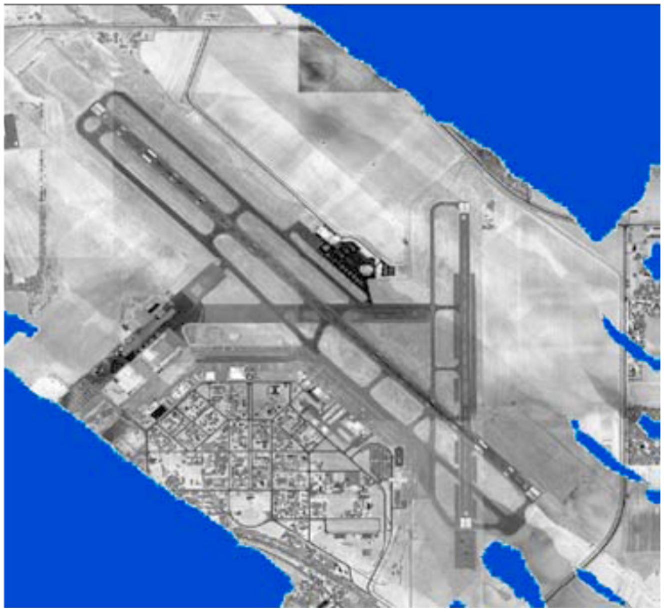


LIDAR Workflow for Airport Obstruction Analysis

(Courtesy of Optimal Geomatics, Inc.)

LIDAR Obstruction Identification





LIDAR Intensity Images

Conventional survey and photogrammetry provide data only discreet locations selected by operator; and **LIDAR** computerized workflow provides survey points over entire survey area features (obstacles and terrain)

LIDAR Point Spacing Specifications

LIDAR survey supplemented with aerial photography (digital or film)

Maximum Across-Track Horizontal Point Spacing	Maximum Along-Track Horizontal Point Spacing	Maximum Vertical Point Spacing (tilted Sensors only)	Corresponding Point Density
0.18 m	0.18 m	0.50 m	30 points/m^2

Airborne LIDAR Survey Specification Posted on NGS Web Site

www.**ngs**.noaa.gov/RSD/Airport**SOW**.pdf

ACRP 03-01 Project Info

http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=135

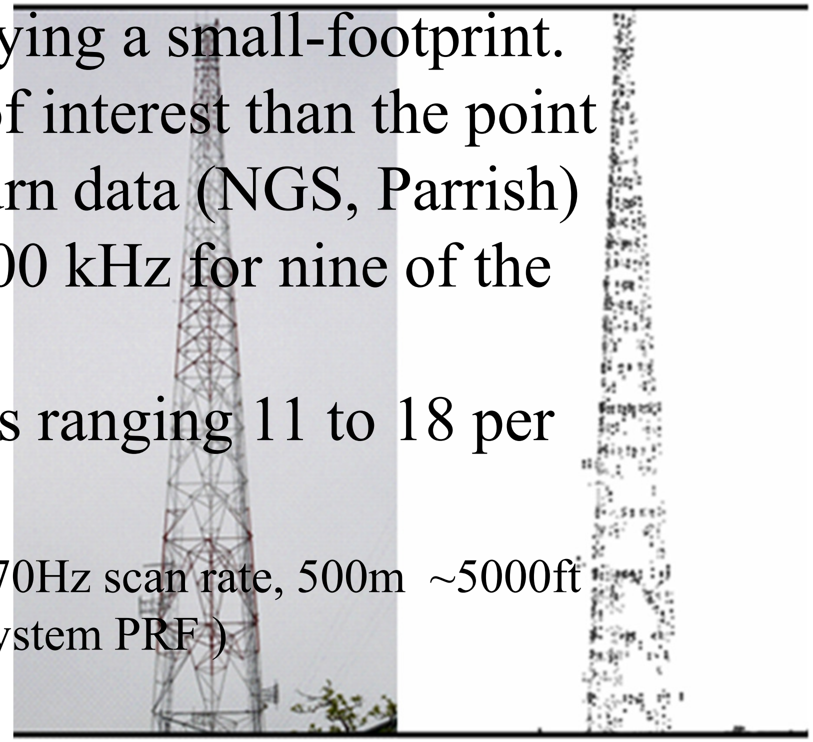
Responsible Senior Program Officer: Andrew C. Lemer

Research Results Digest 10

Advances In LIDAR Technology for Airport Surveying

- Full-waveform LIDAR systems employing a small-footprint.
- 252% more points on vertical objects of interest than the point clouds generated from the discrete-return data (NGS, Parrish)
- Maximum PRF of above 150 kHz to 500 kHz for nine of the reviewed above 70 kHz PRF systems.
- Maximum point density in a single pass ranging 11 to 18 per sq m.

(Assuming 75 m/s aircraft speed, ±20˚ scan angle, 70Hz scan rate, 500m ~5000ft flying height above ground level, and maximum system PRF)



- For100 kHz or higher PRF with appropriate flight mission parameters and overlapping flightlines it is possible to achieve denser point spacing up to 30 points per sq m.

LIDAR Survey Data Processing

Three-Dimensional Georeferenced Point Cloud Data

Intensity Data

Obstruction and Terrain Mapping,

CAD, Geospatial software

(fusion with imagery)

Airport Obstruction Chart, Airport Layout Plan, *eALP*,
Airport GIS, Engineering Analysis, and
Asset Management Applications

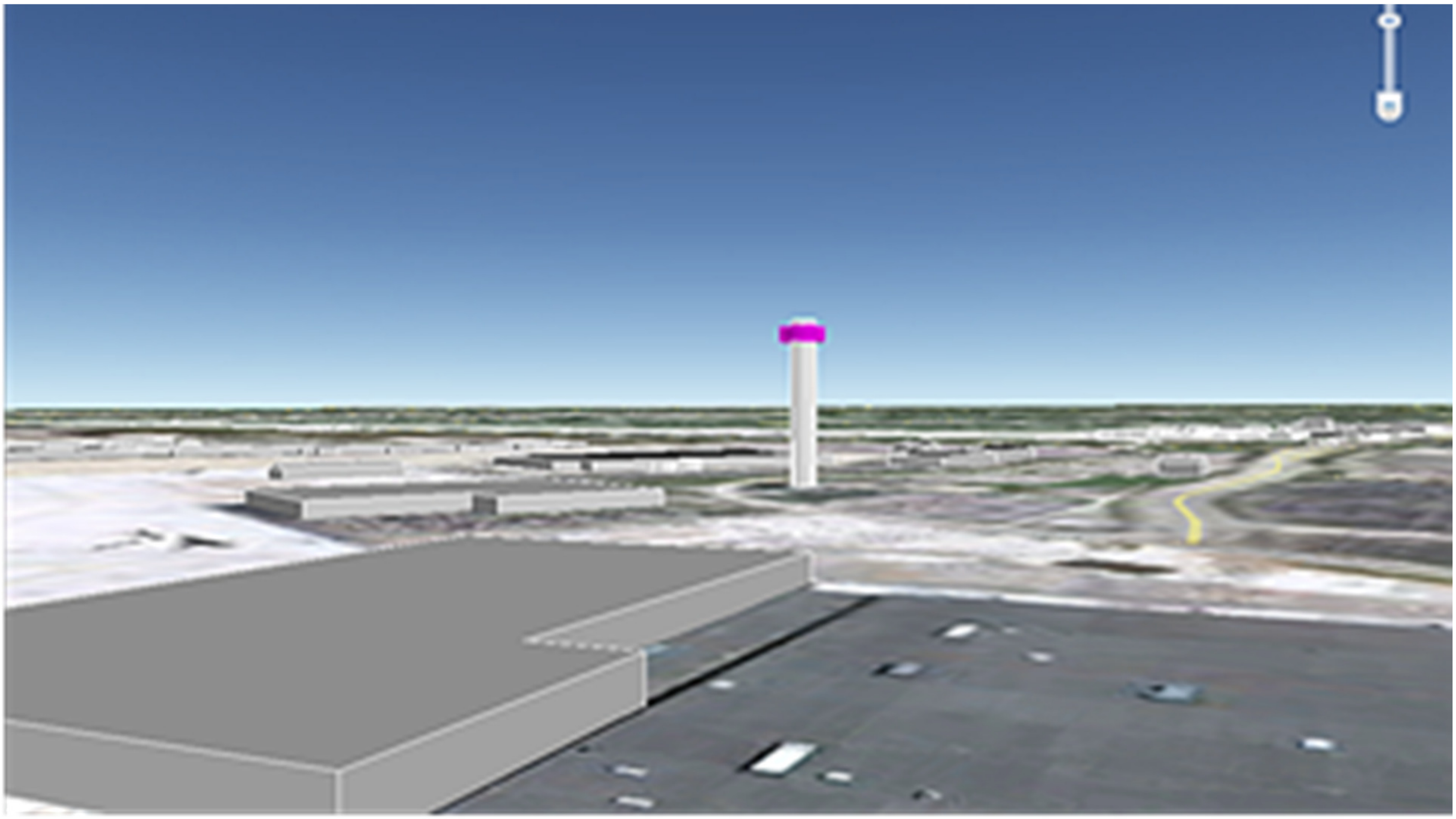
3D Feature Extraction For Airport Infrastructure Assets

- Airport assets can be visualized in a **GIS map** as planimetric features using georeferenced aerial imagery and orthophoto for producing eALP.

- The planimetric can be further used to create **built and non-built surface map** to estimate heat-island effects and sustainability dimensions.
- Geospatial mapping of **3D feature**s can enhance asset inventory.

GeoGenesis™ Photogrammetric Software Suite

Louisville Intl. Airport: 3D Features Extracted in GoogleEarth



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